

This Page Is Inserted by IFW Operations  
and is not a part of the Official Record

## **BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning documents *will not* correct images,  
please do not report the images to the  
Image Problem Mailbox.**

Our File No. 9281-4706  
Client Reference No. S US02262

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE  
APPLICATION FOR UNITED STATES LETTERS PATENT

INVENTOR: Toru Aoyagi

TITLE: Compact Circuit Module

ATTORNEY: Gustavo Siller, Jr.  
BRINKS HOFER GILSON & LIONE  
P.O. BOX 10395  
CHICAGO, ILLINOIS 60610  
(312) 321-4200

EXPRESS MAIL NO. EV 327 136 946 US

DATE OF MAILING 11/2/03

## COMPACT CIRCUIT MODULE

This application claims the benefit of Japanese Patent Application No. 2002-331157, filed on November 14, 2002, which is incorporated herein by reference.

5

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

The present invention relates to a compact circuit module suitable for use in an electronic device such as a transmitter-receiver.

10

#### 2. Description of the Related Art

As shown in Fig. 8, a known circuit module (for example, see Japanese Unexamined Patent Application Publication No. 9-186510) has a structure in which a tabular circuit board 51 composed of a multilayer substrate has a variety of electrical components 52 mounted thereon.

15

Such a circuit module is dimensionally large in the plane of the circuit board and also requires a box-shaped cover (not shown) composed of a metal plate for electrically shielding the electrical components 52.

20

The known circuit module has problems in that it is dimensionally large and expensive because of the tabular circuit board 51 structure on which the electrical components 52 are mounted and a box-shaped cover composed of a metal plate being needed for electrically shielding the electrical components 52.

25

## SUMMARY OF THE INVENTION

Accordingly, an advantage of the present invention is to provide a circuit module which is dimensionally small in the plane of a circuit board and inexpensive.

As a first solution for the above problems, a circuit module according to the present invention includes an electrically insulating base including a first wiring pattern and a cavity; at least one first electrical component disposed in the cavity; and a lid formed so as to cover the cavity and including a second wiring pattern. The insulating base includes a circuit board composed of laminated substrates and a sidewall protruding from the board surface of the circuit board and forming the cavity together with the circuit board, and the lid has at least one second electrical component fixed thereto. Also, the second electrical component is located in the cavity when the lid is fixed on the upper surface of the sidewall so as to cover the cavity, and the first and second wiring patterns are connected to each other with at least one connecting conductor.

With this structure, the first and second electrical components are separately disposed on the insulating base and the lid, respectively, thereby achieving a circuit module which is dimensionally small.

When the insulating base and the lid have a conductive film or the like disposed around the outer peripheral surfaces thereof, an electrically shielded structure is obtained, thereby eliminating a cover composed of a metal

plate, and thus achieving a less-expensive and highly-producible circuit module.

As a second solution for the above problems, the sidewall has the at least one connecting conductor disposed therein, thereby easily connecting the first wiring pattern on the insulating base and the second wiring pattern on the lid, and thus achieving a highly-producible circuit module.

As a third solution for the above problems, the insulating base has a partitioning wall disposed therein, partitioning the inside of the cavity, and the partitioning wall has the at least one connecting conductor disposed therein, thereby allowing the first and second wiring patterns to have more connecting junctions disposed therebetween, and thus achieving a circuit module with which a electrical connections between the lid and the circuit board of the insulating base are easy to design and manufacture especially in the middle part of the insulating base and of the lid.

As a fourth solution for the above problems, the lid is composed of a multilayer substrate, thereby increasing the density of a circuit of the lid and thus achieving a compact circuit module.

As a fifth solution for the above problems, the lid is composed of a low-temperature calcined ceramic, thereby achieving a readily manufactured circuit module.

As a sixth solution for the above problems, the lid has mutually facing electrodes disposed on the inner and outer surfaces thereof so as to form a capacitor, thereby achieving

a compact and easily tuned circuit module.

As a seventh solution for the above problems, the lid is formed of a metal plate and an insulating film fixed to the metal plate, and the insulating film has the second wiring pattern disposed thereon and at least one second electrical component fixed thereto, thereby making the lid thin and allowing the insulating film to be reliably attached thereto.

As an eighth solution for the above problems, the insulating base is composed of a low-temperature calcined ceramic, thereby achieving a readily manufactured circuit module.

As a ninth solution the above problems, the sidewall is formed in an enclosing manner and is bonded to the lid with an adhesive so that the cavity is hermetically sealed, thereby achieving a circuit module which is reliably resistant to dust and moisture, and thus delivers excellent performance for a long period.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an exploded perspective view of a circuit module according to a first embodiment of the present invention;

Fig. 2 is a perspective view illustrating a state in which a lid of the circuit module according to the first embodiment is turned upside down;

Fig. 3 is a sectional view of a major part of the circuit module according to the first embodiment;

Fig. 4 is a perspective view illustrating a lid of a

circuit module according to a second embodiment of the present invention;

Fig. 5 is a perspective view illustrating a state in which the lid of the circuit module according to the second  
5 embodiment is turned upside down;

Fig. 6 is an exploded perspective view of a circuit module according to a third embodiment of the present invention;

Fig. 7 is a sectional view of a major part of the  
10 circuit module according to the third embodiment; and

Fig. 8 is a perspective view of a known circuit module.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

The accompanying drawings illustrating circuit modules  
15 according to the present invention will be briefly described. Fig. 1 is an exploded perspective view of a circuit module according to a first embodiment, Fig. 2 is a perspective view illustrating a state in which a lid of the circuit module according to the first embodiment is turned upside down, and  
20 Fig. 3 is a sectional view of a major part of the circuit module according to the first embodiment.

Fig. 4 is a perspective view illustrating a lid of a circuit module according to a second embodiment of the present invention, and Fig. 5 is a perspective view  
25 illustrating a state in which the lid of the circuit module according to the second embodiment is turned upside down. Fig. 6 is an exploded perspective view of a circuit module according to a third embodiment of the present invention, and

Fig. 7 is a sectional view of a major part of the circuit module according to the third embodiment.

The structure of the circuit module according to the first embodiment of the present invention will be described with reference to Figs. 1 to 3. An insulating base 1 which may be a laminate of a low-temperature calcined ceramic (LTCC) has a circuit board 2 composed of a multilayer substrate, a sidewall 3 formed in an enclosing manner so as to be continuous along the sidewall periphery and protruding from the board surface of the circuit board 2, a cavity 4 formed by the circuit board 2 and the sidewall 3, and a partitioning wall 5 may partition the inside of the cavity 4 creating more than one cavity.

Each of the circuit board 2, the sidewall 3, and the partitioning wall 5 may be formed by laminating a plurality of sheets of a low-temperature calcined ceramic.

The circuit board 2 has a first conductive wiring pattern 6 formed therein and also on the front surface thereof lying in the cavity 4. The sidewall 3 and the partitioning wall 5 respectively have connecting conductors 7 and connecting conductors 8 formed therein and having an electrical connection with the first wiring pattern 6.

The connecting conductors 7 and 8 extend to the upper surfaces of the side wall 3 and the partitioning wall 5, and are formed by, for example, filling a conductive paste in holes perforated in the sidewall 3 and the partitioning wall 5, respectively.

A part of the connecting conductors 7 are electrically

connected to corresponding side electrodes (not shown) at cuts 3a formed in the sidewall 3 so as to be connected to a mother board.

5 Connecting conductors 7 and 8 may be disposed along the inner surfaces of the sidewall 3 and the partitioning wall 5 of the insulating base 1, respectively.

The circuit board 2 has a variety of first electrical components 9 mounted thereon, which are connected to the first wiring pattern 6 on the circuit board 2 in a  
10 state in which they are placed in the cavity 4.

A tabular lid 10 may be a laminate of a low-temperature calcined ceramic and has a second wiring pattern 11 formed on the lower surface thereof, including a plurality of lands 11a, and also a variety of second electrical components 12 mounted  
15 on the same.

In an assembly state in which the second electrical components 12 are located in the cavity 4, the lid 10 is disposed on the upper surfaces of the sidewall 3 and the partitioning wall 5 so as to cover the cavity 4 and is fixed  
20 to the insulating base 1 by bonding it to the sidewall 3 such as with an adhesive (not shown) along the entire peripheries thereof.

When the lid 10 is fixed to the insulating base 1, the inside of the cavity 4 may be hermetically sealed with a  
25 bonding material, which may be an adhesive, whereby a desired electrical circuit (for example, a transmitting-receiving circuit) is constructed such that the connecting conductors 7, 8 formed in the insulating base 1 are electrically connected

to the corresponding lands 11a formed on the lid 10 so as to connect the first and second wiring patterns 6 and 11 to each other.

Meanwhile, the insulating base 1 and the lid 10 may have  
5 a conductive film or a conductive layer formed around the outer peripheral surfaces thereof so as to electrically shield the electrical circuit constructed in the cavity 4.

The structure of the circuit module according to the second embodiment of the present invention will be described  
10 with reference to Figs. 4 to 5. The lid 10 has a grounding conductive layer 13 and an electrode 14 facing the conductive layer 13, respectively formed on the upper and lower surfaces thereof. The electrode 14 and an electrode 13a serving as a part of the conductive layer 13 and facing the electrode 14  
15 form a capacitor.

The capacity of the capacitor can be tuned by removing part of the electrode 13a.

Since the remaining structure of the circuit module according to the second embodiment is the same as in the  
20 first embodiment, the same components are identified by the same reference numerals, and their description is omitted.

The structure of the circuit module according to the third embodiment of the present invention will be described with reference to Figs. 6 to 7. A lid 15 is composed of a  
25 thin metal plate 16 and a tabular insulating film 17 fixed to the metal plate 16 with an adhesive or the like.

The metal plate 16 has a tabular portion 16a and a plurality of bent portions 16b extending approximately

orthogonal from the tabular portion 16a in a bent manner, and the insulating film 17 is fixed on the lower surface of the tabular portion 16a.

5 The lid 15 has the second wiring pattern 11 having the lands 11a in the same fashion as in the first embodiment and the second electrical components 12, both fixed on the lower surface of the insulating film 17.

When the circuit module is assembled such that the second electrical components 12 are located in the cavity 4, 10 the insulating film 17 is disposed on the upper surfaces of the sidewall 3 and the partitioning wall 5 so as to cover the cavity 4, and the lid 15 is fixed to the insulating base 1 by, for example, soldering the bent portions 16b to the outer peripheral surface of the insulating base 1.

15 In this arrangement, a desired electrical circuit (for example, a transmitting-receiving circuit) is constructed such that the lands 11a formed on the insulating film 17 are electrically connected to the corresponding connecting conductors 7,8 formed in the insulating base 1 so as to 20 connect the first and second wiring patterns 6 and 11 to each other.

The inside of the cavity 4 may be hermetically sealed by bonding the lid 15 and the sidewall 3 along the entire peripheries thereof with an adhesive (not shown) or other 25 material.

Since the remaining structure of the circuit module according to the third embodiment is the same as in the first embodiment, the same components are identified by the same

reference numerals, and their description is omitted.

Although an insulating film is used in the third embodiment, a porcelain enamel board or other suitable insulating material may be used instead of the insulating  
5 film.